stitute, and had given much labor to the investigation of the history of his nativet own (Byberry), and to the study of his family genealogy.

It is remarkable that a man burdened with such exacting and responsible business cares, should have been able to accomplish so much in what were to him mere avocations, and botanists cannot help recalling the similar instances of Dr. Wm. Darlington and David Townsend, of West Chester, Pa., both bank officers, and both most ardent and successful botanists. And yet it is to be feared that Mr. Martindale overtaxed his strength, and perhaps had he shortened his hours of labor he might have been spared to the world for many years longer. Symptoms of failing health had led him to resign his position, within a week or two before his death, in order that he might find resoration by travel, and he had intended a visit to South America.

J. H. REDFIELD.

Anatomy as a Special Department of Botany.*

BY EMILY L. GREGORY.

The question of the exact limitation and relative importance of the various departments of botany is by no means a simple one. To verify this assertion it is necessary only to consider briefly the definitions given by some of the best writers of botanical text books. In our own country there is perhaps no higher authority than that of Asa Gray, who in his text book of 1857 says: Physiology is the study of the way a living being lives and grows and performs its various operations. The study of plants in this view is the province of Vegetable Physiology. The study of the form and structure of the organs or parts of the vegetable by which its operations are performed, is the province of Structural Botany. The two together constitute Physiological Botany," &c. The title page of the same book is headed " Gray's Lessons in Botany and Vegetable Physiology," and again in the text we find " Botany is the name of the science of the vegetable kingdom in general."

* Read before the American Association for the Advancement of Science, Rochester Meeting, 1892.

"The study of plants as to their kinds is the province of Systematic Botany, and finally, "Other departments come to view when, we consider plants in their relations to other things, as Geographical, Agricultural, Medical, Botany and the like."

By these definitions, vegetable physiology is not identical with physiological botany, for the latter is made to include vegetable physiology and structural botany, and the name of the book, "Lessons in Botany and Vegetable Physiology," implies that botany, does not include vegetable physiology. Again systematic botany is here made a distinct, separate department of equal rank with physiology and structural botany. However, if we examine closely into the practical outcome of these definitions, we shall find that except the inaccuracy of excluding vegetable physiology from the subject *botany*, they correspond with the manner of growth and development of these different departments in this country.

If Structual Botany is understood to include two parts, namely: the doctrine of external form and that of internal structure, it is easy to see in what sense Gray included structual in the province of Physiological Botany. The doctrine if the internal structure of plants, or Anatomy, is so closely connected with that of physiology, that to teach the elements of either successfully, both must be combined. It is probably not too much to say that in comparison with the progress made in the science of vegetable life in other countries, we are as yet not much beyond the elementary stage. Certainly we were not at the time Gray wrote the above definitions. At that date systematic botany occupied by far the most important place, and was therefore rightfuily ranked of equal if not of greater importance than the other branches. Also it was according to the normal method of developing a science to group together subjects less thoroughly understood and less studied under a general term whose exact meaning was not sharply defined, This term was physiology, or, as Gray puts it, physiological botany. There were then practically two divisions of the science, systematic and physiological botany, a more or less thorough knowledge of the former being necessary to a successful study of the lattar. This, though perhaps never before stated in so many words, was about the actual status of the subject at that

date. This book was revised in 1868 with no change in the definitions (?) In 1887 the "Lessons in Botany" were printed in which the definitions of the various branches of the subject correspond much more nearly to the present condition of the science. Even here there is a striking lack of definiteness and precision as compared with the definitions of the other later authors. For example, he says: "The study of the actions of plants, or of their parts, of the ways in which a plant lives, grows, and acts, is the province of physiological botany or vegetable physiology." Notice here the use of the two terms as identical. Pfeffer defines plant physiology as follows: "Physiology has the task, to find out exactly, according to measure and number, the processes which take place in an organism, to trace back these processes to their origin, and to learn their signification in the economy of the organism." The most restricted text book definition of the word physiology is probably that of Wiesner's, who says: "The province of physiology, using the term in its restricted sense, is to trace back all the phenomena of life to mechanical processes." Nothing could be more true and at the same time comprehensible than this. The only objection to it is, it is too restricted to cover what even Wiesner himself includes in his text book under the head of physiology in its restricted sense.

With the exception of this peculiar view of the province of physiology, Wiesner's definitions of the branches of the science very fairly represent the present accepted use of terms and manner of treatment. His exposition of the subject is briefly as follows: There are two branches which include the entire field of scientific botany, morphology and physiology. The first concerns itself entirely with the form relations of plants and their ports, the second with the conditions and phenomena of the life of the plant. Morphology is subdivided in four branches. 1. Descriptive morphology, or description of the outer form of organs; 2. The inner structure, or anatomy; 3. Development history, or tracing the development of plant, or organ; 4. Systematic morphology, or tracing the organs back to a few types.

Physiology is subdivided in two brances: 1. Physiology in its restricted sense as defined above; 2. Biology, or the consideration of vital processes, which cannot, at our present stage of knowledge be traced to any mechanical causes.

It is hoped a brief consideration of these views will bring us to our subject, anatomy as a special department of botany. In regard to the province of physiology the restriction made by Wiesner is by no means accepted by the majority of botanists. His use of the term biology is, I believe, peculiar to himself, as nearly all other German botanists and text book writers use it as including that part of botany which treats of certain phases in the life of plants which show most clearly the difference between lifeless and living matter; these are processes concerned in reproduction, in prolonging the life of the individual or species, and in short in the origin and end of living organisms. Accordlng to the present teaching, Pfeffer's definition of physiology covers the meaning, and to this may be added, that it is generally subdivided into physiology of nutrition and that of growth.

Taking up now the morphological side, it may be shown that Weisner's four branches may easily be reduced to two; Anatomy, which stands in close relation to Physiology; Systematic Morphology, holding the same relation to Systematic Botany. In this way the latter includes the three branches, descriptive morphology, development history, and the tracing organs back to a few types, which Weisner names Systematic Morphology, but which may be just as appropriately named Metamorphosis, leaving the term Systematic Morphology to represent the three combined.

Of these three, the first is too well known to require proof of its connection with Systematic Botany. The second has received very little attention frsm our botanists, and it may be of interest to explain briefly in what way it contributes to our knowledge of plant classification. Again quoting from Weisner, Development History is of service to Systematic Botany in two ways: First, by the examination of similar organs throughout all their phases of growth, their similarity is much more clearly shown than by simply studying them when fully grown, for example, leaves; dissimilar ones, on the other hand, appear more distinctly and sharply separate, as stem and root. Secondly, by the study of organs in all their phases of growth, the leaves, by which they develop, are made clear, and their probable relationships more easily determined than by the study of fully-developed organs and plants. The third branch, Metamorphosis, is plainly connected with classi-

fication, it is also equally evident that it does not represent a department of the science of the same grade as that of Anatomy.

Summing up these conclusions we practically return to the same position which Gray assumed so long ago. As a science, botany may be divided in two branches, morphology and physiology. Practically it is divided into systematic botany and physiology, or into two branches of such a character that one is and must be represented by systematic, the other by experimental and theoretical work. To illustrate more fully what is meant by this, as well as to substantiate the statement, one example may be given, the botanical work in the University of Berlin. It is well known that there are two departments about equal in rank, physiology and systematic botany. In the department of physiology, of which Prof. Scwendener is at the head, general botany is taught, that is, the different branches as above described as included under the head of scientific botany; the principal work, however, of this department is physiological and that of the highest order. In the other school, of which Prof. Engler has charge, systematic work forms the main line of study, and this is known as *special* botany. There is no other provision for special branches, except that which falls naturally into one or the other of these two provinces. Thus while the instruction given in both cases necessarily is not limited by close lines of definition, the work really shapes itself in two directions, and these two lines are those which represent at the present day, the natural divisions of the subject. As to their relative importance there is not the slightest room for discussion, as no physiologist can succeed without a fair knowledge of systematic botany, while the reverse is equally true.

These somewhat prolix statements of more or less familiar facts were thought necessary in order to define exactly the position which plant anatomy holds to the remaining branches, and its consequent relative importance. It holds a similar relation to physiology that morphological botany does to classification. It is no more possible to succeed in the investigation of questions now interesting the scientific world in the province of plant physiology, without a thorough knowledge of the minutest details of internal structure, than it is to take up questions of similar importance in the field of plant classification without a practical know-

ledge of that part of morphology on which classification mainly depends.

At the time Gray wrote his definitions as above quoted, this branch of the science was in its infancy; twenty years after this date, De Bary finished his text book on "The Comparative Anatomy of Phanerogams and Higher Cryptogams," which is now the standard authority on anatomical questions. Fifteen years have passed since De Bary's book was published, and during this time much progress has been made in this branch. Such progress in any department renders necessary a corresponding growth in text books and in methods of treatment. Whatever may be true of text books in general, it is believed safe to say that the English written text books of the day are singularly deficient in this respect. Abstruse and difficult physiological problems are introduced to students illy-prepared to handle them, while they try to meet the deficiency by a partial description of anatomical characteristics, a knowledge of which is necessary even to a comprehension of the questions. Not only must the standard of text books be raised, but the methods of instruction must be improved if we expect to cope successfully with some of the most interesting problems of the day.

For example, such subjects as twining stems, transmission of stimulus, nutation, and other intricate questions are often given to the students who have completed an elementary course in what we term type work, or sometimes, general botany, which includes a bird's-eye view of the various classes of plants with only the merest elements of anatomical training. Expensive pieces of apparatus are exhibited and their manner of working explained to students whose training is wholly inadequate to enable them to make an intelligent use of such apparatus.

Assuming the truth of our statements it is comparatively easy to find an explanation for this condition. Very few of our institutions of learning recognize the "Science of the Vegetable Kingdom" as a separate independent subject, and still fewer have any conception of its real nature, of its position in other countries, and of its importance in reference both to the practical and theoretical questions of the day. It is, however, not so easy in a limited space to show clearly in what manner anatomy is so closely

connected with physiology, and in this way to verify the statements made. One or two illustrations may be taken from the prominent discussions now occupying plant physiologists.

Anatomy may be divided into, or it consists of two parts, that of the cell, and that of tissues. In the study of the cell, for convenience, it is treated as wall and contents. With the contents as the seat of life, or Lebens-träger, are connected most of the questions concerning nutrition or the changes undergone in substance used as food. With the wall, as well as with certain parts of the contents, are connected questions of organized structure among which are some of the most absorbing interest and in whose solution some of the keenest thinkers of the time are employed.

Wiesner has recently published a book entitled "The Elementary Structure and Growth of Living Substance," in which he proposes a theory in several respects directly opposed to the accepted one which is known as the micellar theory of Naegeli. For example, according to the latter theory, the units of structure or micellae of organized matter are held together by the law of attraction and the cause of enlargement of such structures on taking in water is due to the penetration of water between the micellae of the substance composing the structure. According to Wiesner the units of structure are held together by fine protoplasmic strings, and as water is drawn away, by evaporation, the interstices between the units are filled with air; if water be added it is taken into the units themselves, which become enlarged proportionately; the change in volume caused by change in water contents depends, therefore, on change in the diameter of the units, and not on the lengthening or shortening of the protoplasmic strings.

Physiology treats of how a living organism grows and performs its various actions; this question, therefore, lies at the very foundation of physiology, as on it depends largely the manner of growth and other forms of motion. This will be seen by considering such subjects as the law of leaf position. Were Wiesner's theory the correct one, Schwendener's law, which is based upon Naegeli's theory would fall to the ground, and another reason must be sought in consonance with the facts. The position and authority of Wiesner is too well known to require mention here, and it is probably equally well known how strong are the arguments against most of the peculiar views which he advocates.

Other illustrations may be given to show the connection between a knowledge of the anatomy of tissues and that of their physiology. If a leaflet of the sensitive plant be touched in a certain way, it closes, and one after another all the remaining leaflets follow its example in regular order of succession. How is the effect communicated from the first leaf to the second and so on? This question has already occupied much time and energy in its attempted solution, but how can one hope to be able to add anything to that already known about it, without a thorough knowledge of the anatomy of the tissues through which the stimulus passes! Another more hackneyed subject, but even better than this as an illustration, is the so-called water question. If any one doubts the necessity of training in anatomy as requisite to physiological study, let him attempt to explain the present theory of the ascent of water through the trunks of high trees, to a person ignorant of plant anatomy.

In one of the editions of Gray's structural botany in speaking of the various departments of the science, he says: "A complete system of classification can only be made when our knowledge of all the other departments becomes complete." If this is the end toward which we are all striving, the importance of a proportionate and symmetrical development of the various branches can hardly be over-estimated.

Notes on Some Algæ in the Herbarium of the Long Island Historical Society.

By W. G. FARLOW.

Recently I received from Dr. Jelliffe some specimens of marine algæ from the collections of Mr. J. Hooper, Mr. Calverly and Col. Pike, now in the Herbarium of the Long Island Natural History Society, and since several of the species are scarcely to be found in other herbaria, the following notes may be of interest.

Of *Callithamnion Dietziæ*, Hooper, three specimens, were sent. That numbered 109 is the type specimen, and out of it was cut a piece which is now the only specimen of the species in the Harvey Collection in Trinity College, Dublin. Another specimen without